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DRAFT REGULATORY GUIDE

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DRAFT REGULATORY GUIDE DG-1008
REACTOR COOLANT PUMP SEALS

A. INTRODUCTION

The General Design Criteria contained in 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," in Appendix A, "General Design Criteria for Nuclear Power Plants," provide for a high-quality reactor coolant pressure boundary. Criterion 14 states that the reactor coolant pressure boundary is to be designed, fabricated, erected, and tested to have an extremely low probability of abnormal leakage, rapidly propagating failure, and gross rupture.

Criterion 1, "Quality Standards and Records," of Appendix A to 10 CFR Part 50 includes a requirement for a quality assurance (QA) program to provide adequate assurance that structures, systems, and components important to safety will perform their safety functions.

Criterion 13, "Instrumentation and Control," requires that instrumentation be provided to monitor variables and systems over their anticipated ranges for normal operation, for anticipated operational occurrences, and for accident conditions as appropriate to assure adequate safety, including those variables and systems that can affect the fission process, the integrity of the reactor core, the reactor coolant pressure boundary, and the containment and its associated systems. Criterion 13 also requires that controls be provided to maintain these variables and systems within prescribed operating ranges.

Criterion 30, "Quality of Reactor Coolant Pressure Boundary," of Appendix A to 10 CFR Part 50 requires that components that are part of the reactor coolant pressure boundary be designed, fabricated, erected, and tested to the highest quality standards practical. Criterion 30 requires that means be provided for

This regulatory guide is being issued in draft form to involve the public in the early stages of the development of a regulatory position in this area. It has not received complete staff review and does not represent an official NRC staff position.

Public comments are being solicited on the draft guide (including any implementation schedule) and its associated regulatory analysis or value/impact statement. Comments should be accompanied by appropriate supporting data. Written comments may be submitted to the Regulatory Publications Branch, DFIPS, Office of Administration, U.S. Nuclear Regulatory Commission, Washington, DC 20555. Copies of comments received may be examined at the NRC Public Document Room, 2120 L Street NW., Washington, DC. Comments will be most helpful if received by July 31, 1991.

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detecting and, to the extent practical, identifying the location of the source of reactor coolant leakage.

Criterion 44, "Cooling Water," requires a cooling water system be provided to transfer heat from structures, systems, and components important to safety to an ultimate heat sink. The system safety function is to transfer the combined heat load of these structures, systems, and components under normal operating and accident conditions. Suitable redundancy in components and features, as well as suitable interconnections, leak detection, and isolation capabilities, are to be provided to ensure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.

Paragraph (a), "Requirements," of 10 CFR 50.63, "Loss of All Alternating Current Power," requires that each light-water-cooled nuclear power plant be able to withstand and recover from a station blackout (i.e., loss of the offsite electric power system concurrent with reactor trip and unavailability of the onsite emergency ac power source) of a specified duration. Section 50.63 requires that, for the station blackout duration, the plant be capable of maintaining core cooling and appropriate containment integrity. It also identifies the factors that should be considered in specifying the station blackout duration, including leakage from reactor coolant pump (RCP) seals. The development and promulgation of 10 CFR 50.63 made an assumption regarding the magnitude of RCP seal leakage during a station blackout event. It was left to GI-23 to validate that assumption regarding seal leakage with no seal cooling.

This guide describes means acceptable to the NRC staff for enhancing safety by including the RCP seals in the QA program to better ensure that the reactor coolant pressure boundary has an extremely low probability of abnormal leakage, of rapidly propagating failure, and of gross rupture. This guide also describes methods acceptable to the NRC staff for enhancing the capability of nuclear power plants to withstand loss-of-seal-cooling events, given the potential for failure of RCP seals.

Any information collection activities mentioned in this draft regulatory guide are contained as requirements in 10 CFR Part 50, which provides the regulatory basis for this guide. The information collection requirements in 10 CFR Part 50 have been cleared under OMB Clearance No. 3150-0011.

B. DISCUSSION

Failure of an RCP seal that can result in a loss-of-coolant accident (LOCA) can occur during normal operation when leakage through the seals exceeds the capacity of the normal makeup systems, as has occurred in operating plants. RCP seal failure can also occur during off-normal (abnormal) conditions such as station blackout, loss of component cooling water (CCW), or loss of service water (SW) scenarios when loss of seal cooling represents a potential common cause failure (CCF) for all RCP seals.

RCP seals limit the leakage of reactor coolant along the pump shaft, directing the majority of this flow back to the chemical and volume control system (CVCS), with the remainder being directed to the reactor coolant drain tanks. In limiting the reactor coolant leakage to containment, the RCPs use a series of primary and secondary seals. Therefore, these seals become part of the reactor coolant system pressure boundary. The primary seals (metallic oxides, carbides, and graphite) limit the leakage of reactor coolant across the interface between rotating and stationary RCP elements. The secondary seals (elastomer O-rings, U-cups, and teflon channel seals) prevent leakage between stationary mechanical elements of the RCP seal or those elements that have only a slight relative motion. Both the primary and secondary seals are intended to be continuously cooled during pump operation and at hot shutdown conditions when RCPs are not operating.

Some RCP seal failures have resulted in a loss of primary coolant that exceeded the normal makeup capacity of the plant. These seal failures were therefore a small LOCA. In all the seal failures that have occurred to date, emergency core cooling capability was available to replenish reactor coolant lost through seal leakage. However, RCP seal failures have continued to occur, and such failures represent a source of further challenges to the emergency core cooling system (ECCS).

There are also some potential common mode vulnerabilities that could both cause an RCP seal LOCA and render the mitigating systems inoperable, and thus they could lead to core melt. One such scenario involves the complete loss of the CCW system, which provides cooling water to the seal thermal barrier heat exchanger. In some plants, the reactor coolant makeup system pumps or CVCS charging pumps that supply RCP seal injection flow are also cooled by the CCW system. Furthermore, in some plants, the reactor coolant makeup pumps are used as the high pressure safety injection pumps. Other plants may have separate high pressure safety injection pumps, but these may also be cooled by CCW. Therefore, for some plants, complete loss of CCW could result in the equivalent of a small-break LOCA caused by seal degradation, with no high pressure safety injection pumps available for emergency core cooling. This sequence of events could lead to core melt and could be caused by the loss of all ac power (station blackout).

Another potential common mode scenario involves the complete loss of all service water (SW). Essentially all plants rely on the SW system, either directly or indirectly via the CCW system, for cooling the CVCS charging pumps and the high head safety injection pumps. For plants with this common mode vulnerability, loss of all SW could result in a sequence of events that could lead to core melt.

The objectives of the actions described in the Regulatory Position of this guide are to:

(1) Reduce the probability of RCP seal failures,
(2) Have plant procedures that would minimize the safety impact of RCP seal failure or degradation,
(3) Have sufficient instrumentation to permit proper implementation of the procedures,
(4) Have independent means of providing cooling to the RCP seals for severe events, such as station blackout, which make the normal seal cooling systems inoperable.

Clearly, the General Design Criteria contained in Appendix A to 10 CFR Part 50 provide for a high-quality reactor coolant pressure boundary. Criterion 14 states that the reactor coolant pressure boundary is to be designed, fabricated, erected, and tested so as to have an extremely low probability of abnormal leakage, of rapidly propagating failure, and of gross rupture. Paragraph (c) of 10 CFR 50.55a, "Codes and Standards," requires that components that are part of the reactor coolant pressure boundary meet the requirements for Class 1 components in Section III of the ASME Boiler and Pressure Vessel Code. However, Section III of the ASME Boiler and Pressure Vessel Code has included specific exemptions for seal components under NB-3411.2 and NB-2121(b). As a result, the RCP seal has not always been treated as important to safety in the pressure boundary; based on operating experience, its failure probability is considerably higher than that of the passive elements of the primary system boundary.

The safety concerns regarding seal failure apply to pressurized water reactor (PWR) plants, since boiling water reactors (BWRs) exhibit significantly lower leak rates from seal failures, primarily because of their lower system pressure. In addition, the effects of leakage from pump seal failures in BWRs can be mitigated by several systems, including reactor core isolation cooling, high pressure coolant injection, and normal feedwater. BWRs also have isolation valves in the recirculation loops.

The Reactor Safety Study, WASH-1400 (Ref. 1), published in October 1975, estimated that breaks in the reactor coolant pressure boundary from all sources in the range of 0.5 to 2 inches in diameter would occur with a frequency of 1E-3 per reactor year. This frequency of small-break LOCA was the largest contributor to the PWR core-melt sequences in WASH-1400. Based on licensee event report (LER) review in the early 1980s, RCP seal failures, with leak rates equivalent to those of small-break LOCAs, were actually occurring at a frequency of about 1E-2 per reactor year, an order of magnitude greater than the pipe break frequency used in WASH-1400. Thus the overall probability of core melt caused by small breaks is dominated by RCP seal failures.

RCP seal failures have occurred from many causes during normal operation, including maintenance errors, wear out, vibration, corrosion, contamination, abnormal pressure staging, overheating of the seal cavity, operator error, improper venting, and defective parts. The resulting seal leakage has varied from very low rates up to 500 gallons per minute. Further, when such failures occur there is no way to isolate the seal. Plant shutdown and depressurization are necessary to control the leak, and partial draindown of the system is often necessary to stop the leak. RCP seal failures are important from a risk perspective when the seal leakage exceeds the capacity of the normal makeup systems (i.e., a LOCA results) or, because of station blackout or loss of CCW scenarios, when there is a loss of seal cooling that can lead to a common cause failure for all RCPs.

Technical studies of RCP seal and operating experience have identified a need for improving quality control over seal materials and fabrication, installation, and maintenance, as well as seal operations. These improvements are expected to decrease the current failure rate for the RCP seals. There is also a need to improve instrumentation and monitoring capabilities in order to identify degraded seal performance early enough to take corrective action to mitigate seal failure.

Research involving RCP seal parameters typical of station blackout conditions indicated that certain secondary seal materials are not adequate to remain functional for representative station blackout durations. Also, seal instability (popping open) has been identified as a likely seal failure mode under station blackout conditions. Seal "popping open" can occur because of seal face flashing, increased axial seal friction, or partial extrusion and jamming of the axial seal. Based on the results of such studies, there is a need to provide seal cooling during postulated loss of cooling events such as station blackout or failure of the CCW or SW systems to prevent or minimize the probability of common mode failure of all RCP seals.

Reference 2 is a summary of the technical findings of the staff's studies of the RCP seal failure issue.

C. REGULATORY POSITION

1. QA CONSIDERATIONS

Each PWR plant should treat the RCP seal assembly as a component of the safety-related reactor coolant pressure boundary. The QA program should include the RCP seal assembly consistent with its importance to safety, in accordance with Criterion II of Appendix B to 10 CFR 50. Licensee and vendor QA programs should cover design, manufacture, testing, procurement, installation, maintenance, inspection, and training and qualification of personnel.

2. OPERATING PROCEDURES AND INSTRUMENTATION

In conjunction with the RCP seals being included in the QA program, each PWR plant should provide appropriate operating procedures and instrumentation.

2.1 Operating Procedures

Each PWR plant licensee should provide procedures to properly operate the seals under normal conditions and to detect and identify the correct course of action for any given off-normal situation. These procedures should provide guidance on how to use the monitored parameters to identify degradation early enough to prevent or mitigate cascade failure of multi-stage seal assemblies. These procedures should reflect RCP seal manufacturer and nuclear steam supply system (NSSS) vendor instructions and any plant-specific features. In addition, operators should be trained and qualified in the proper implementation of these procedures.

As a minimum, RCP seal procedures should be provided for normal plant operation conditions, including pump startup, pump shutdown, and off-normal conditions including:

- Loss of seal injection flow (where applicable),
- Loss of cooling to the thermal barrier heat exchanger,
- Loss of all seal cooling (the procedures should be consistent with Regulatory Position 3 of this guide),
- Pump restart after loss of all seal cooling.

Table 1 gives an example of some types of off-normal conditions for which instructions have been provided by one RCP seal manufacturer. Additional details are in NUREG/CR-4544, Reference 3.

2.2 Instrumentation and Operating Limits

Each PWR plant licensee should provide instrumentation sufficient to implement the operating and off-normal procedures and should be capable of monitoring variables and systems over their anticipated ranges for normal operation, anticipated operational occurrences, and accident conditions. In this regard, it is expected that the RCP seal manufacturer and NSSS vendor-recommended instrumentation and operational limits (e.g., alarm setpoints) on the monitored parameters would be available or exceptions justified. By means of proper procedures, instrumentation, and training, the operator should have the knowledge to determine the correct course of action for any operational conditions, anticipated operational occurrences, and accident conditions.

Although some exceptions will occur from design variations among the different seal manufacturers, the monitored parameters should include:

- Valve positions referenced in operating procedures,
- RCP shaft axial and radial displacement and vibrations,
- Seal pressure, temperature, and leakage, and
- Temperature and flow rate for staging flow (hydrodynamic seal), seal injection, thermal barrier heat exchanger, and seal injection pump cooling.

Examples of seal instrumentation and alarm setpoints recommended by three major U.S. RCP seal manufacturers or NSSS vendors are shown in Table 2. This information has been taken from NUREG/CR-4544 (Ref. 3) and represents the knowledge at that time.

3. SEAL COOLING FOR OFF-NORMAL CONDITIONS

A number of off-normal plant conditions such as station blackout, loss of CCW, or loss of SW could lead to a loss of seal cooling, which in turn could lead to seal failure and a consequent loss of reactor coolant inventory (e.g., small-break LOCA). Of particular concern during such off-normal conditions would be the potential for a seal LOCA coincident with the loss of ECCS functions because of common dependencies.

The following conditions can result in loss of all RCP seal cooling if certain plant-specific dependencies exist:

- Loss of all ac power (i.e., station blackout as defined in 10 CFR 50.2),[1]
- Loss of CCW function,
- Loss of SW function,
- Inadvertent termination of RCP seal cooling from a safety-injection or containment-isolation signal or loss of a pneumatic system.

Therefore, in order to maintain seal cooling for off-normal conditions, each PWR should comply with either Regulatory Position 3.1 or 3.2:

[1]If, as part of the implementation of the station blackout rule, a plant is re-establishing seal cooling within 10 minutes (e.g., by an alternate ac supply which powers the seal injection function), then seal cooling is not considered lost.

3.1 Plant-Specific Dependencies

Plant-specific dependencies associated with the conditions described in Regulatory Position 3 above should be evaluated and eliminated. Any modifications should, as a minimum, meet the design guidelines described in Appendix A of this guide and the quality assurance program in Appendix B of this guide. If any dependencies can not be eliminated, independent seal cooling should be provided in accordance with Regulatory Position 3.2.

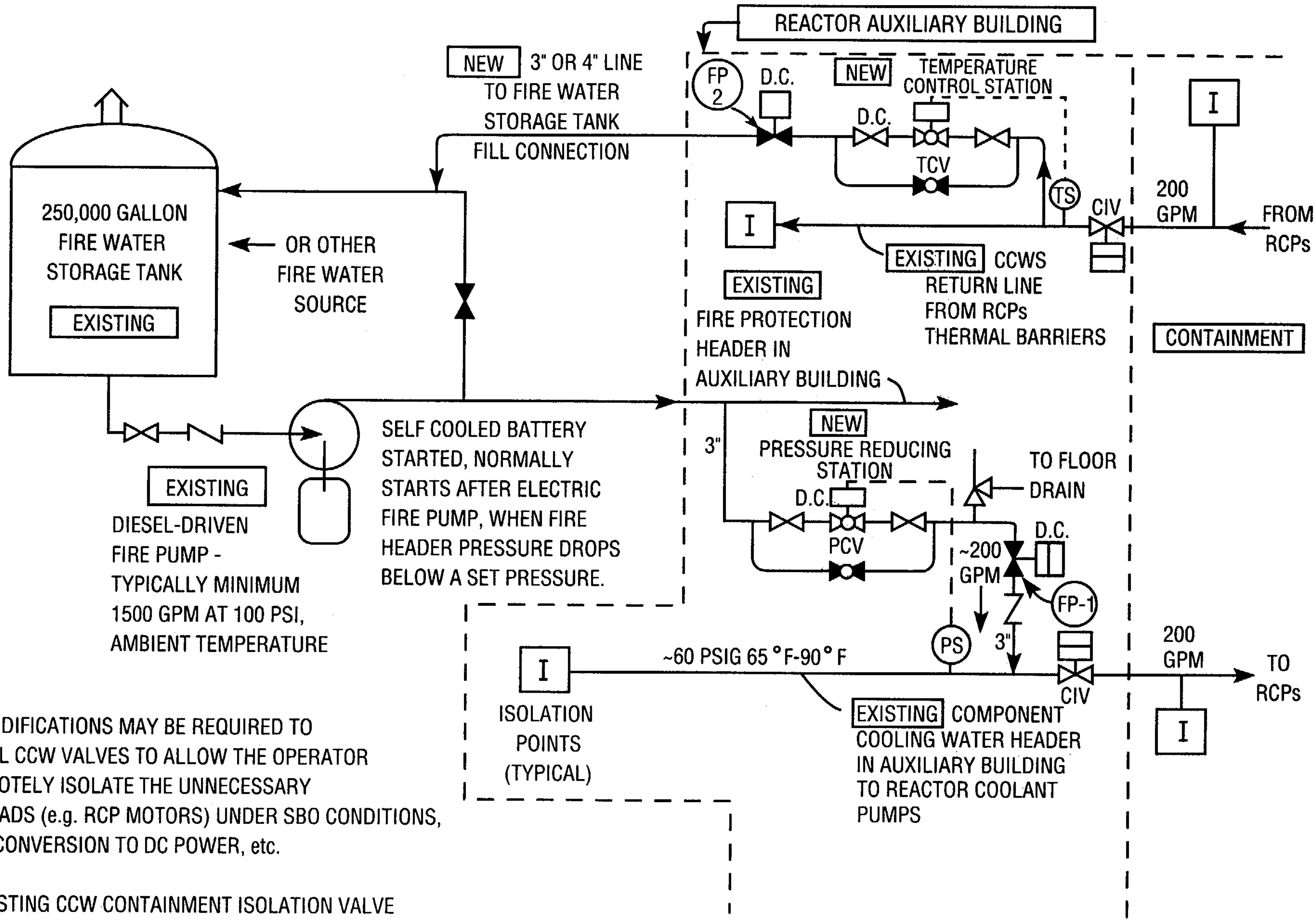
3.2 Independent Seal Cooling

Seal cooling should be provided that, as a minimum, meets the design guidelines described in Appendix A of this guide and the quality assurance program in Appendix B of this guide and that is independent of normal seal cooling and the support systems to the extent practicable. Some existing seal cooling piping runs may be shared if the probability of failure of the piping is shown to be acceptably low or if, upon piping failure, the leak can be isolated and other seal cooling can be maintained. An example arrangement is given in Figure 1.

D. IMPLEMENTATION

The purpose of this section is to provide information to applicants regarding the NRC staff's plans for using this regulatory guide.

This proposed guide has been released to encourage public participation in its development. Except in those cases in which an applicant proposes an acceptable alternative method for complying with specific portions of the Commission's regulations, the method to be described in the active guide reflecting public comments will be used in the evaluation of PWR licensees and applicants who are required to comply with General Design Criterion 14 of Appendix A to 10 CFR Part 50 and with 10 CFR 50.63.



NOTES:

I : MODIFICATIONS MAY BE REQUIRED TO SEVERAL CCW VALVES TO ALLOW THE OPERATOR TO REMOTELY ISOLATE THE UNNECESSARY CCW LOADS (e.g. RCP MOTORS) UNDER SBO CONDITIONS, e.g. BY CONVERSION TO DC POWER, etc.

CIV: EXISTING CCW CONTAINMENT ISOLATION VALVE

Figure 1. Example of Independent Seal Cooling

Table 1. Selected Off-Normal Operational Conditions for Which Westinghouse Provides Instructions

- High flow at No. 1 seal leakoff
- Low flow at No. 1 seal leakoff
- High flow at No. 2 seal leakoff
- High flow at No. 3 seal
- High temperature at seal inlet (radial bearing)
- High temperature at No. 1 seal leakoff
- Loss of seal injection water flow
- Loss of No. 3 seal injection water flow (cartridge seal system only)
- Loss of component cooling water to the thermal barrier heat exchanger
- Loss of seal injection water flow and component cooling water flow (e.g., loss of CCW, station blackout)
- Returning an RCP to operation (thermal shock)

Table 2. Example of Vendor-Recommended Instrumentation and Operating Limits

A. Westinghouse Cartridge Seal System

Location	Parameter	Normal Value (Range)	Setpoint
No. 1 Seal			
Inlet (At Radial Bearing)	Temperature	130°F (60-150°F)	Hi = 170°F
Outlet	Temperature	150°F (60-235°F)	Hi = 190°F
	Leak Rate	3 gpm (0.2-5.0 gpm)	Hi = 5.0 gpm Lo = 0.8 gpm
Inlet-Outlet	Differential Pressure	2235 psid (200-2470 psid)	Lo = 275 psid
No. 2 Seal	Leak Rate	3 gph	Hi = 1.0 gpm
	Pressure	30 psig (15-60 psig)	N/A
No. 3 Seal	Standpipe Level	Varies	Hi = 31 in. Lo = 58 in.
No. 1 Seal Leakoff	Pressure	40 psig	N/A
(Return Line)	Temperature	160°F	N/A
	Flow Rate	Same as No. 1 Seal Outlet	Same as No. 1 Seal Outlet
No. 2 Seal Leakoff	Leak Rate	3 gph	Hi = 1.0 gpm
Seal Injection	Temperature	(120-130°F)	Hi = 135°F
	Flow Rate	8 gpm	Lo = 6 gpm
	Differential Pressure	N/A	N/A
Component Cooling Water	Temperature (Thermal Barrier Heat Exchanger Inlet)	80°F (60-105°F)	Hi = 105°F

N/A = not available or not applicable.

Table 2. (Continued)

A. Westinghouse Cartridge Seal System (Continued)

Location	Parameter	Normal Value (Range)	Setpoint
Component Cooling Water (Continued)	Flow Rate (Thermal Barrier Heat Exchanger Inlet)	40 gpm (35-60 gpm)	Lo = 35 gpm
	Flow Rate (Combined RCP-CCW Return Flow)	N/A	N/A
RCP Shaft	Vibration (X&Y Shaft Orbit)	(3-6 mil peak-to-peak)	Hi = 10 mil

N/A = not available or not applicable.

Table 2. (Continued)

B. Byron Jackson RCP Seal Cartridge

Location	Parameter	Normal Value (Range)	Setpoint
Lower (1st) Seal	Pressure	2140 psig (±100 psig)	None
Middle (2nd) Seal	Pressure	1427 (±100 psig)	Lo = 1200 psig Hi = 1600 psig
Upper (3rd) Seal	Pressure	713 psig (±100 psig)	Lo = 500 psig Hi = 900 psig
	Temperature	See Controlled Bleed-off (CBO) below	
	Leak Rate (3-stage System)	0-0.08 gpm	Hi = 0.17 gpm
Controlled Bleed-off (CBO)	Flow Rate	1.5 gpm (±0.15 gpm)	1.8 gpm
	Temperature	(125-165°F)	165°F
Seal Injection	Flow Rate	(8-10 gpm)	N/A
	Temperature	(95-135°F)	N/A
Component Cooling Water	Flow Rate	(45-60 gpm)	45 gpm
	Temperature	(95-105°F)	N/A
RCP Shaft	Vibration (X&Y Shaft Orbit)	(0-0.010 in. peak-to-peak)	0.015 in. (peak-to-peak)

N/A = not available or not applicable.

Table 2. (Continued)

C. Bingham International Seal System

Location	Parameter	Normal Value (Range)	Setpoint
Lower (1st) Seal	Pressure	2150 psig (±50 psig)	N/A
	Temperature	120°F (±10°F)	156°F
Middle (2nd) Seal	Pressure	1434 psig (±50 psig)	N/A
Upper (3rd) Seal	Pressure	717 psig (±50 psig)	N/A
	Temperature	See Staging Flow (CBO) below	
	Leakage Rate	0-0.39 gpm	Hi = 1.0 gpm
Staging Flow (CBO)	Flow Rate	1.5 gpm (±0.05 gpm)	Hi = 1.80 gpm Lo = 0.36 gpm
	Temperature	134°F (±10°F)	165°F
Seal Injection Water	Flow Rate	9.5 gpm	N/A
	Temperature	N/A	N/A
Heat Exchanger Recirc. Flow Out of Bearing	Temperature	122°F (±10°F)	N/A
	Flow Rate	N/A	N/A
Cooling Water	Temperature	85°F	Lo = 60°F Hi = 105°F
	Flow Rate	50 gpm	N/A
RCP Shaft	Radial Displacement (X&Y Shaft Orbit)	0 to 0.015 in.	±0.025 in.

N/A = not available or not applicable.

REFERENCES

1. U.S. Nuclear Regulatory Commission, "Reactor Safety Study," WASH-1400, October 1975.

2. C.J Ruger and W.J. Luckas, "Technical Findings Related to Generic Issue 23: Reactor Coolant Pump Seal Failure," NUREG/CR-4948, U.S. Nuclear Regulatory Commission, March 1989.

3. W.J. Luckas, C.J. Ruger, A.G. Tingle, et al., "Reactor Coolant Pump Seal Related Instrumentation and Operator Response," NUREG/CR-4544 (BNL-NUREG-51964), U.S. Nuclear Regulatory Commission, December 1986.

APPENDIX A

Design Guidelines for Independent Seal Cooling

Safety-Related Equipment	Not necessary to meet Regulatory Position 3 of this guide, but the existing Class 1E electrical systems must continue to meet all applicable safety-related criteria.
Redundancy	Not necessary.
Power Independence	Any power required should be independent of both the normal and emergency ac power systems.
Independence from Other Safety-Related Systems	Ensure that the existing safety system functions are not compromised, including the capability to isolate components, subsystems, or piping, if necessary.
Seismic Qualification	Not necessary, but ensure that it does not degrade the seismic design of the Seismic Class 1 Systems, Structures, or Components.
Environmental Consideration	Needed for station blackout event only and not for design basis accident conditions. Procedures should be in place to effect the actions necessary to maintain acceptable environmental conditions for required equipment.
Capacity	In the event of a station blackout, provide sufficient water capacity for RCP cooling for the plant-specific duration to meet 10 CFR 50.63 and Regulatory Guide 1.155. For other loss-of-all-seal-cooling events,

	provide sufficient water capacity for an assumed maximum duration event (approximately 8 hours).
Functional Criteria	Provide sufficient seal cooling to maintain manufacturer's recommended temperature limits. Ensure that the two-phase flow is avoided. (This requires cooling within 10 minutes.)
Quality Assurance	As indicated in Appendix B to this guide.
Technical Specifications for Surveillance, Limiting Condition of Operation	Should be consistent with the Interim Commission Policy Statement on Technical Specifications (Federal Register Notice 52 FR 3789) as applicable.
Instrumentation and Monitoring	Should meet system functional requirements.
Single Failure Criterion	Not necessary to satisfy the single failure criterion.
Common Cause Failure (CCF)	Design should, to the extent practicable, minimize CCF between safety-related and non-safety-related systems.
Human Factors	Good human factors principles should be considered and documented in the design of the system, instrumentation, and procedures.

APPENDIX B

Quality Assurance Program for Non-Safety-Related Independent Seal Cooling

The quality assurance (QA) program provided here is applicable to the non-safety-related independent seal cooling in Regulatory Position 3 of this guide. Additionally, non-safety equipment installed in conformance with this guide must not degrade the existing safety-related systems. This is accomplished by making the non-safety equipment as independent as practicable from existing safety-related systems. This appendix outlines an acceptable QA program for non-safety equipment to provide backup cooling to the RCP seals when this equipment is not already covered by existing QA requirements. Activities should be implemented from this section as appropriate, depending on whether the equipment is being added (new) or is existing.

1. Design Control and Procurement Document Control

Measures should be established to ensure that all design-related criteria used in complying with this guide are included in design and procurement documents, and that deviations therefrom are controlled.

2. Instructions, Procedures, and Drawings

Inspections, tests, administrative controls, and training should be prescribed by documented instructions, procedures, and drawings, and they should be implemented in accordance with these documents.

3. Control of Purchased Material, Equipment, and Services

Measures should be established to ensure that purchased material, equipment, and services conform to the procurement documents.

4. Inspection

A program for independent inspection of activities should be established and executed by (or for) the organization performing the activity to verify conformance with documented installation drawings and test procedures for accomplishing the activities.

5. Testing and Test Control

A test program should be established and implemented to ensure that testing is performed and verified by inspection and audit to demonstrate conformance with design and system readiness requirements. The tests should be performed in accordance with written test procedures; test results should be properly evaluated and acted on.

6. Inspection, Test, and Operating Status

Measures should be established to identify items that have satisfactorily passed required tests and inspections.

7. Noncomforming Items

Measures should be established to control items that do not conform to specified requirements to prevent inadvertent use or installation.

8. Corrective Action

Measures should be established to ensure that failures, malfunctions, deficiencies, deviations, defective components, and nonconformances are promptly identified, reported, and corrected.

9. Records

Records should be prepared and maintained to furnish evidence that the criteria enumerated above are being met.

10. Audits

Audits should be conducted and documented to verify compliance with design and procurement documents, instructions, procedures, drawings, and inspection and test activities described above.

REGULATORY ANALYSIS

A separate regulatory analysis was not prepared for this regulatory guide. Draft NUREG-1401, "Regulatory Analysis for Generic Issue 23, Reactor Coolant Pump Seal Failures," provides the regulatory basis for this guide and examines the cost and benefits of implementing this regulatory guide. A more detailed cost/benefit analysis is contained in NUREG/CR-5167, "Cost/Benefit Analysis for Generic Issue 23, Reactor Coolant Pump Seal Failure." These NUREG documents are available for inspection and copying for a fee at the NRC Public Document Room, 2120 L Street NW, Washington, DC. NUREG-1401, a draft, is available free, to the extent of supply, upon written request to the Office of Information Resources Management, Distribution Section, U.S. Nuclear Regulatory Commission, Washington, DC 20555. Copies of NUREG/CR-5167 may be purchased from the Superintendent of Documents, U.S. Government Printing Office, P.O. Box 37082, Washington, DC 20013-7082; or from the National Technical Information Service, Springfield, VA 22161.

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